

## WHAT IS CLAIMED IS:

1. A coaxial spindle cutting saw for dicing wafers and singulating substrates, comprising:

a spindle housing for mounting on a cutting  
5 saw;

a coaxial spindle mounted in said spindle housing for movement therewith,

said coaxial spindle comprising a center spindle having first mounting means for positioning a first  
10 cutting saw blade mounted on said center spindle,

said coaxial spindle further comprising an outer hollow spindle mounted on said center spindle for rotation therewith and for axial movement relative thereto,

second mounting means for positioning a second cutting saw blade on said outer hollow spindle,  
15

a spindle drive motor coupled to said spindles for rotating both said center spindle and said outer hollow spindle together at the same rotational speed; and

spindle positioning means coupled to one of said spindles for accurately positioning one of said cutting saw blades relative to the other cutting saw blade.  
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2. A coaxial spindle cutting saw as set forth in claim 1 which further includes a second spindle housing mounted on said same cutting saw; and

four spindles in said two spindle housings  
5 for mounting four cutting saw blades for simultaneously cutting operations.

3. A coaxial spindle cutting saw as set forth in claim 2 wherein said spindle housings are mounted with their spindle axes mounted side-by-side and independently moveable in Y and Z axes.

4. A coaxial spindle cutting saw as set forth in claim 2 wherein said spindle housings are mounted end-to-end in substantially the same axis and independently moveable in Y and Z axes.

5 5. A coaxial spindle cutting saw as set forth in claim 1 wherein said outer hollow spindle further includes an air bearing surface between an inner diameter of the outer hollow spindle and an outer diameter of the center spindle.

6. A coaxial spindle cutting saw as set forth in claim 5 wherein said outer hollow spindle further includes an air-bearing surface on the outer diameter of said outer hollow spindle.

5 7. A coaxial spindle cutting saw as set forth in claim 6 wherein said positioning motor means further includes a voice coil actuating means mounted on said spindle housing for positioning said outer spindle relative to said center spindle.

8. A coaxial spindle cutting saw as set forth in claim 6 wherein said actuating means further includes a moveable actuating arm slideable relative to said spindle housing; and

5 an air-bearing coupling mounted on said actuating arm for movement of said outer spindle.

9. A coaxial spindle cutting saw as set forth in claim 6 wherein said positioning motor means further includes a moveable actuating arm mounted on said spindle housing; and

5 coupling means mounted on said actuating arm for movement of said outer spindle.

10. A coaxial spindle cutting saw as set forth in claim 1 wherein said spindle drive motor is directly coupled to one of said coaxial spindles.

11. A coaxial spindle cutting saw as set forth in claim 1 wherein said spindle drive motor is mounted in or on said spindle housing.

12. A method of making two saw cuts simultaneously, comprising the steps of:

mounting a spindle housing on said cutting saw for Y and Z movement relative to a work station,

5 mounting an outer spindle slideably mounted relative to an inner spindle in said spindle housing to provide a pair of coaxial spindles,

10 providing a spindle drive motor for rotating said inner spindle and said outer spindle together in the same spindle housing,

mounting a first cutting saw blade on said inner spindle and a second cutting saw blade on said outer spindle, and

15 positioning one of said saw blades relative to the other saw blade by moving one of said coaxial spindles relative to the other to position said cutting saw blades juxtaposed each other for simultaneously cutting the same work piece on the workstation.

13. The method as set forth in claim 12 wherein the step of positioning one of said saw blades relative to the other comprises:

providing a voice coil actuator on said  
5 spindle housing, and  
positioning said outer spindle on said inner spindle by actuating said voice coil of said voice coil actuator.

14. The method as set forth in claim 12 wherein  
10 the step of positioning further comprises providing an encoder scale on one of said spindles, and

sensing the position of said encoder scale to position the moving spindle.

15. The method as set forth in claim 12 wherein the step of positioning further comprises providing an encoder sensor scale on an actuating arm of said spindle housing and sensing the position of the encoder scale to  
5 position the moving spindle.

16. A multi-piece hub for dual twin and coaxial spindle cutting saws where the spindles have positioning shoulders for receiving a hub, comprising:

a hub portion for mounting on said position-  
5 ing shoulders,

said hub portion having a flat disc-like flange portion for receiving a cutting saw blade on a radially outer annular surface,

an annular recess in said flat flange por-  
10 tion,

a flat annular receiving portion in the bottom of said annular recess, and

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lock nut means for fitting in said annular recess below said flat disc-like flange portion and for  
15 mounting on a spindle, whereby two said hubs on two of said spindles may be mounted with their flat disc-like flange portions flush against each other.

17. A multi-piece hub as set forth in claim 16 wherein said hub comprises an inner flange portion and an outer flange portion for clamping an annular cutting saw blade there between,

5 said locking means comprises an adapter bushing for fitting into said annular recess, and

said lock nut means for holding said inner and said outer flanges together on a spindle.

18. A multi-piece hub as set forth in claim 16 wherein said lock nut means comprises a locking nut for fitting into the annular recess and for holding said hub onto one of said spindles.

19. A multi-piece hub as set forth in claim 16 wherein said locking means comprises a locking nut adapter for fitting into the annular recess and a locking nut for holding said hub onto one of said spindles.